MS-1

TRANSMITTERS, TELEVISION "S" BAND SYSTEM

Quarterly Progress Report

Prepared for

National Aeronautics and Space Administration
George C. Marshall Space Flight Center

Under Contract NAS8-11990

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October 1, 1965
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TABLE OF CONTENTS

STATUS OF FIRST TRANSMITTER

The first transmitter has been virtually completed in its physical manufacture. At the present time, the box contains the power supply, the amplifier tube, various filters, and all circuitry except for the times 8 multiplier, which is still being worked upon separately. All subsections of the transmitter have been individually tested, both on the bench and under varying temperature conditions. All portions of the transmitter have operated satisfactorily under these circumstances, with the exception of the times 8 multiplier. If reference is made to the Block Diagram Sketch, Figure 1, one may see the Octupler designated as A6.

The Video Amplifier, A1, has been completed and tested, and performs quite well. The video bandwidth of this circuitry is approximately 30 Mc, as against the 8 Mc required. This circuit consists of a removable pre-emphasis front end which drives an integrated circuit feedback amplifier, followed by Q1, a low gain DC coupled amplifier which drives Q2, an emitter follower, which reduces the source impedance to a low enough value to properly drive the subsequent voltage controlled oscillator (not shown on Figure 2, the schematic of the Video Amplifier and Keyed Clamp).

The output signal proceeds through C11 and is ultimately clamped by the diode bridge involving CR3-6. A sample of the video is taken

from the emitter follower, Q3, and is fed to Q4, an amplifier which is used to strip away the video signal information and to leave only the sync pulses which are used to gate the clamp via the blocking oscillator stage involving transistor, Q5. The diode bridge is normally biased off, and this bias is overcome by the blocking oscillator pulse, which brings the diodes into firm conduction. The diodes form a bridge, with the lowest corner attached to ground. When the bridge is operating the upper junction, which is attached to the coupling capacitor, C11, is also driven to ground, regardless of input signal. This circuit has been tested on a Telechrome Television Transmission Test Generator. Sine squared pulses and tone bursts have been observed to be nearly ideal. There is essentially no ringing on the $\frac{T}{2}$ sine squared pulse.

Figure 3 is the schematic for the VCO and Buffer Amplifier which receives the signal from the video amplifier, A1. The output frequency of the VCO is at 177.5 Mc. This unit has been completed and temperature tested for stability of both power and frequency. The VCO sketch shows the compartmentation of the unit involving at the upper left hand corner the components necessary to keep extraneous voltages from getting on the power leads. The pair of complimentary emitter followers receives the input video signal at J1. This proceeds through a terminated artificial line involving L6 into the oscillator compartment, the middle section in the top row.

A very small amount of power is taken from this oscillator and fed into the buffer amplifier in the upper right hand compartment. The output is then inductively coupled out at J2, and proceeds to the signal amplifier shown on the Block Diagram as A3. The compartment in the lower row, next to the right end, contains the temperature compensation circuitry in order to frequency stabilize the VCO. Note that these sketches are working sketches used by the engineers as this equipment was built. Apologies are offered for the fact that these are not yet in final schematic form, however, due to the rush on this particular endeavor, it was necessary to proceed without waiting for formal drawings.

The signal amplifier doubler raises the power level and frequency of the video modulated RF signal to 355 Mc and about 50 milliwatts, and sends this to the balanced parametric up converter, A4. No particular problems were encountered with the signal amplifier doubler section, A3. The energy source for the up converter comes from the Pump Driver, A5, Octupler, A6, and through the Pump Filter A7. This combination needs to supply 1925 Mc at about a quarter of a watt. The Pump Driver, A5, is shown in Figure 4. This starts out with a stable crystal oscillator operating at 120.3125 Mc. A very small amount of power is coupled from this unit. Note that the ground connection at C2 represents a small inductance in series with L1, which provides the proper coupling ratio. This signal is then amplified into two stages

involving Q2 and Q3. The next to the last compartment on the right is a balanced varactor doubler which raises the frequency to 240.625 Mc. This is followed by Q4, the final amplifier. The power output at J2 is a little more than one watt. This power is used to drive the Octupler, A6.

Figure 5 shows the schematic and the sketched layout of this octupler. The entire development of this transmitter has gone very rapidly with the exception of problems which have occurred in the octupler area. The octupler involves a snap diode made by Hewlett-Packard Associates, CR1, which is shown in the holder entitled, 61-004/A6.3B, C Holder. The input signal at 240.6 Mc is brought in through J1, impedance matched capacitively and fed through L1 to the snap diode. The snap diode stores charge during the forward conduction period, and because of its resistivity profile and physical construction continues to supply this charge for a short time after the RF voltage reverses on the diode. When no more charge is available, the current flow in the diode abruptly stops. As current had previously been flowing in L1, this causes the current to switch very abruptly to the path involving the output cavity. This cavity is a rod capacitively end tuned which is capacitively coupled to the multiplier, and C4 and C6 provide impedance matching. The output of J2 is taken from an inductive tap on the rod.

The output signal then goes through the Pump Filter, A7, which originally had about 3 db loss and required, therefore, about 500 milliwatts output from the octupler. This power was successfully obtained at room temperature. However, when the ambient was raised, the output broke up and fell to zero. Subsequently, a new pump filter was designed with 1 db loss, thus requiring only about 315 milliwatts from the octupler. This allowed the temperature to be raised further than before, prior to improper operation. As the unit stands now, it runs up to about 75°C without trouble. At this time work is proceeding on this multiplier to find the exact cause of the breakup, and to eliminate it.

The up converter, A4, and its subsequent filter are designed to provide adequate power so that a 1 db insertion loss external filter supplied by Marshall Space Flight Center can be added. The output power then proceeds to the TWT and then through a low pass coaxial filter and comes out at about 20 watts. Tests have been performed which indicate that 22 watts may actually be available at this point. The power supply has been tested with the tube and worked satisfactorily. A gating circuit is used to turn on the high voltage to the TWT. It is arranged in such a way that, with no voltage applied to the gate circuit, the transmitter is fully operative. When it is desired to stop transmission but to leave the oven warmed up and the crystal oscillator running, 28 volts must be applied. This circuitry has been checked and found to operate satisfactorily.

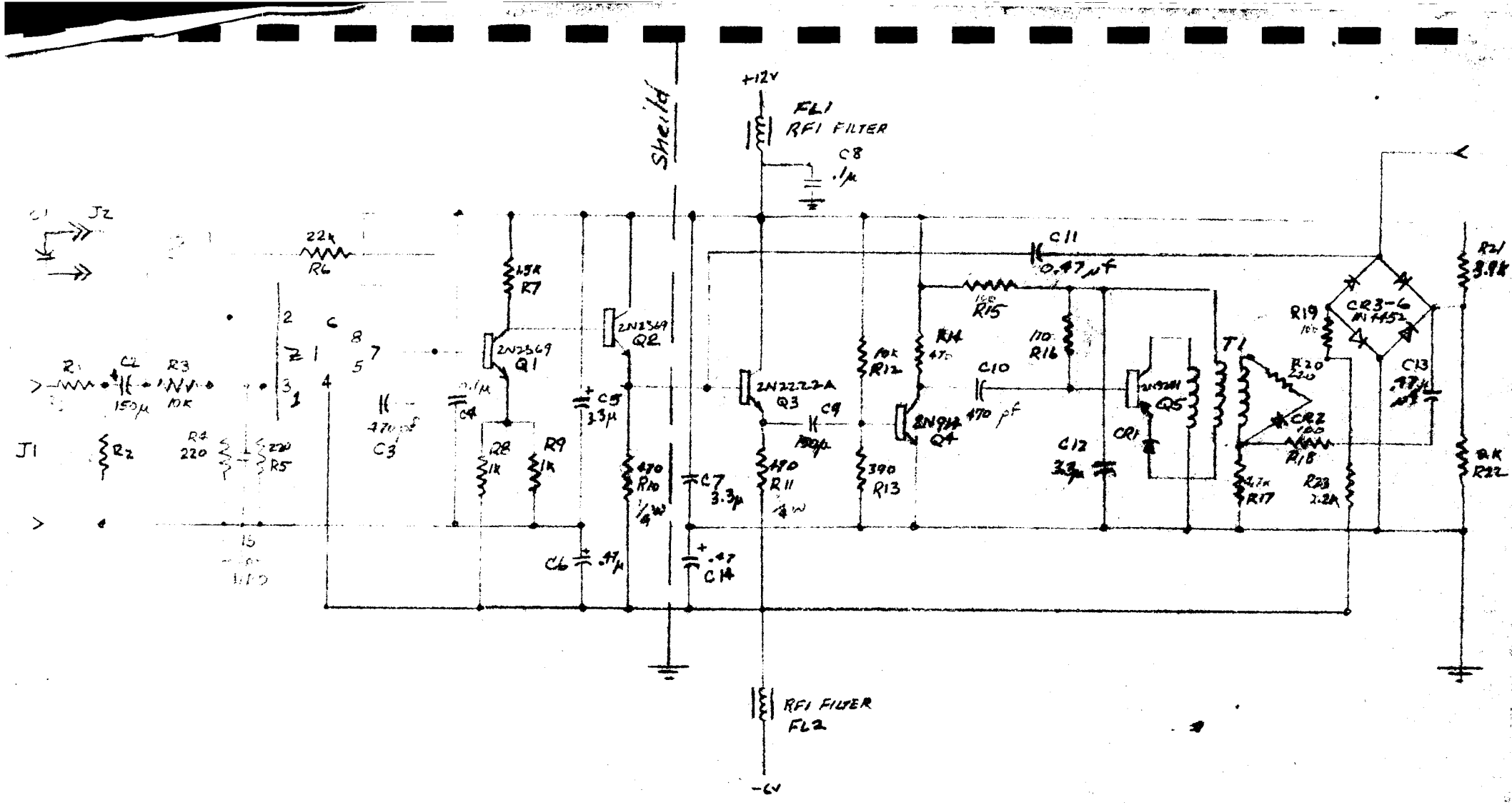
STATUS OF REMAINING TRANSMITTERS

All six power supplies are assembled. The first one has been completely tested and potted. The second pump driver has been completed and tested satisfactorily. The other four pump drivers are completed physically, but not tested.

The second up converter is awaiting the delivery of more diodes; the video amplifier section for the second transmitter is completed and tested; the third one is 50% manufactured, and the fourth, fifth and sixth are 20% completed. The five filament converters are not complete. the signal amplifier and doubler for the second unit is done and tested; the remainder are 95% manufactured. The second VCO and buffer is done and tested, and the third is 95% done; the fourth through sixth are not as yet started. The remaining pump filters and converter filters are not done. The RFI filter for the second unit is complete and tested, and the third unit is complete but not tested. The fourth through sixth units are 20% done. The oven controllers for the remaining units have not been started. The 25 volt supply for the Number 2 Unit is 95% done, but not tested, and the remainder are 50% done. Cables for the second transmitter are 90% finished and have not been started on the remaining units. Castings for all of the cases are on hand. Finished machining is being held on the remaining castings until the first unit is finished. All tubes are on hand.

CONCLUSION

While the delivery of this equipment is now late, due to the problems in the times 8 multiplier, the feeling of the people working on the equipment is that this is a very sound transmitter, and that all of the specifications will be met or exceeded and that the unit should be reproducible. In other words, the general feeling is an optimistic one. All tests performed, except in the one problem area, have been very encouraging. Consequently, if this equipment, in fact, lives up to what presently looks reasonable to expect from it, it might be worthwhile considering lowering the frequency to the more common television band of 1710 Mc for other possible future missions. Such a change would not be a drastic one, and as the frequency is lower, some things would become slightly easier.

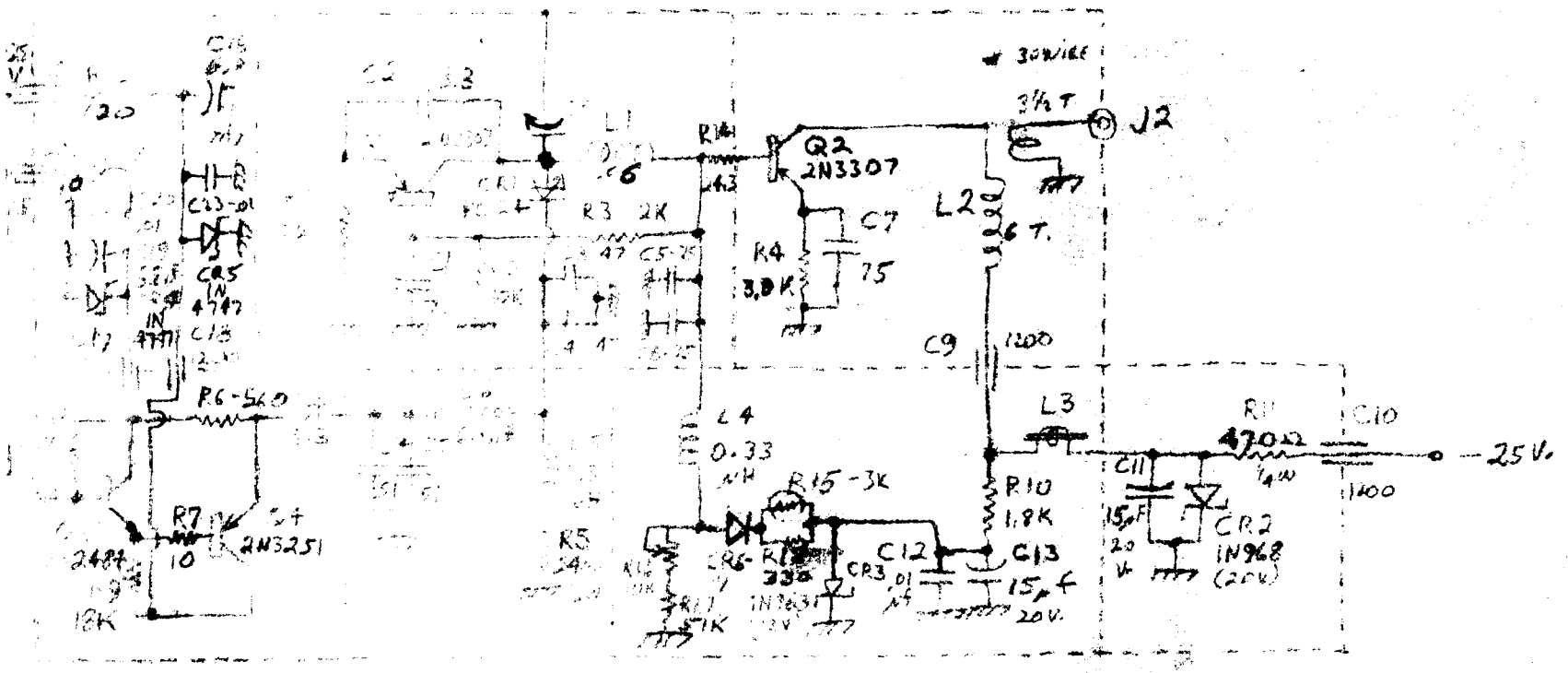


61-004/A1.4

VIDEO AMPLIFIER and KEYED CLAMP

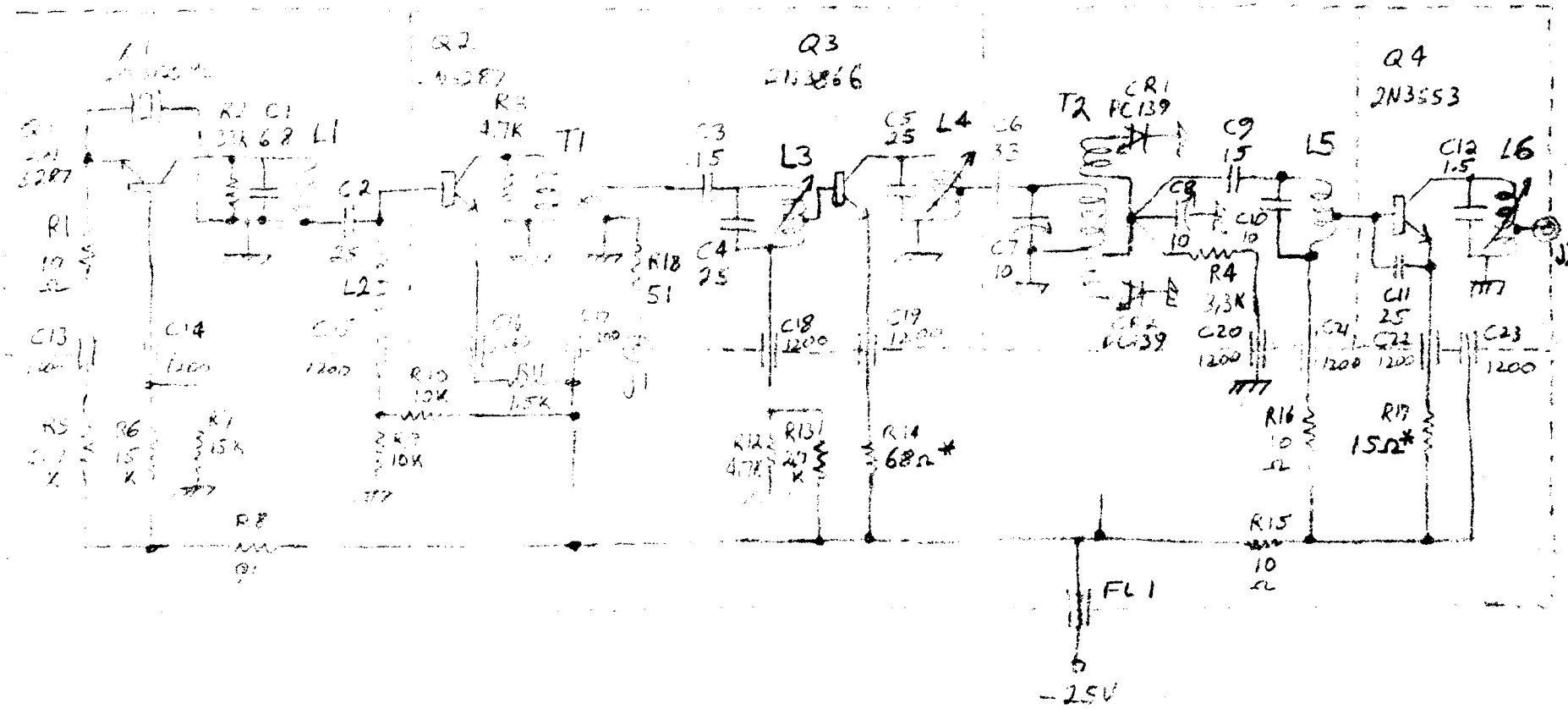
61-004 7/28/65 JEQ.

FIG 2



61-004/A2.1
VCO
Schematic

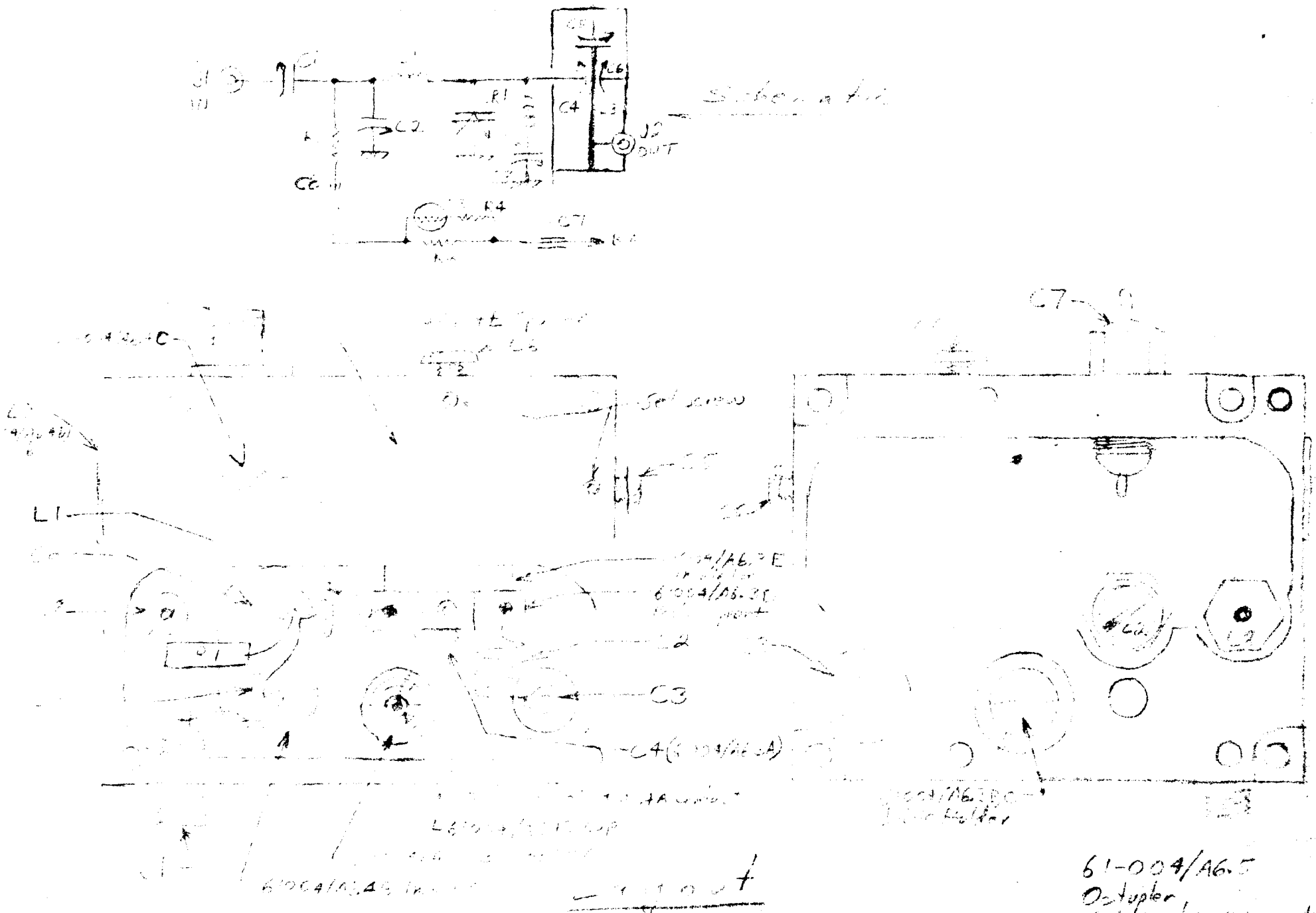
FIG 3



* May vary slightly. Adjust for approx 1.2w out at 25°C and 1.25w. at 90°C

61-004/A5.1
Schematic

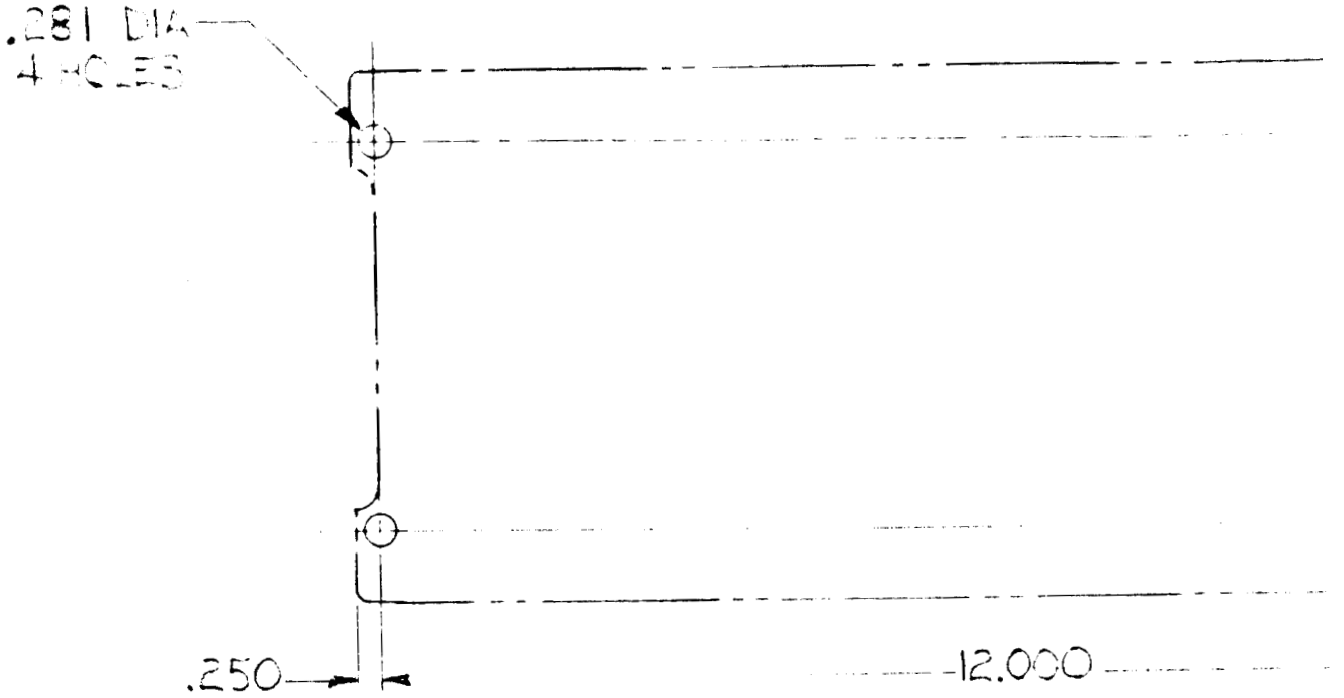
FIG 4



61-004/A6.5
Diplexer
Schematic & Layout

FIG 5

TOP 1



MOUNTING DETAIL
SCALE 1/2
PHANTOM LINE INDICATES OUTLINE
OF BOTTOM MOUNTING SURFACE

J1
MODULATION
INPUT
(GREF 2182)
TYPE TNC

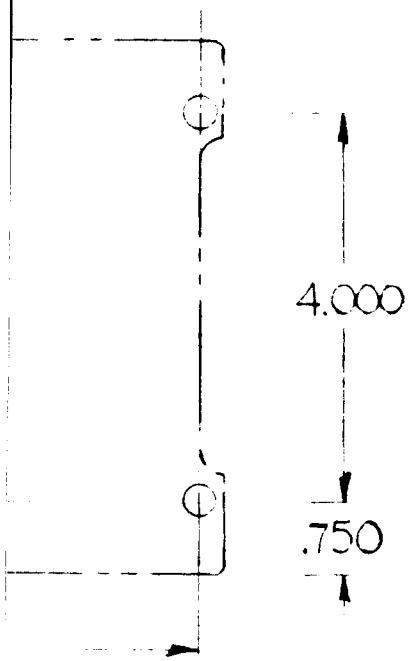
J4
ON/OFF
GATE
A-GATE, B-GND
BENDIX(PTO7H

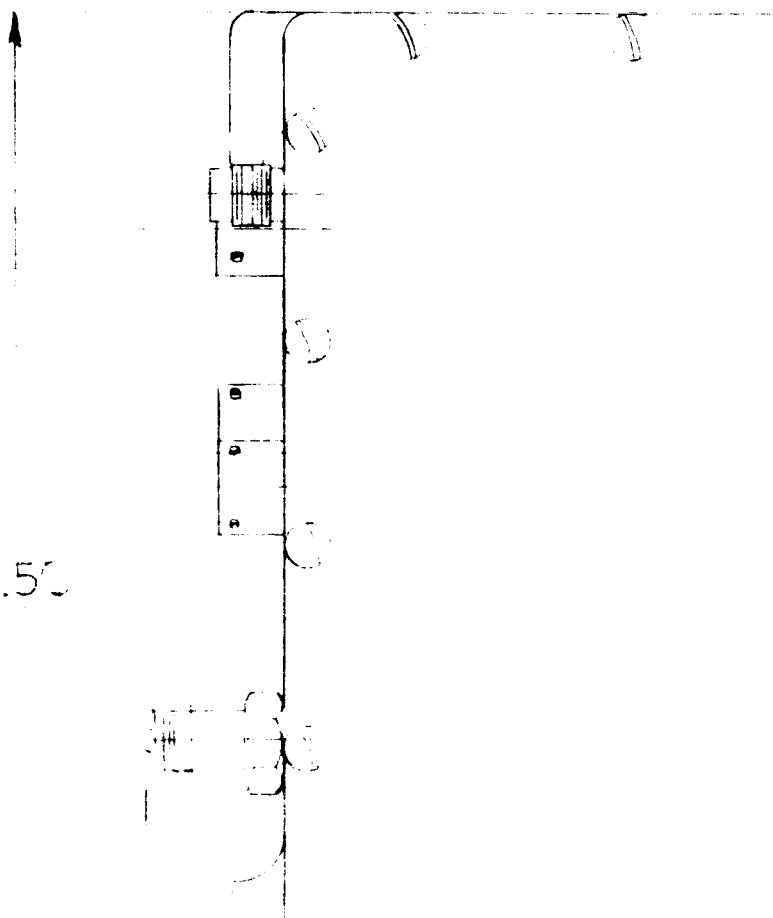
J2
PREMPHASIS DISC
A-IN
B-OUT
C-GRD
BENDIX(PTO7H-8-3PW

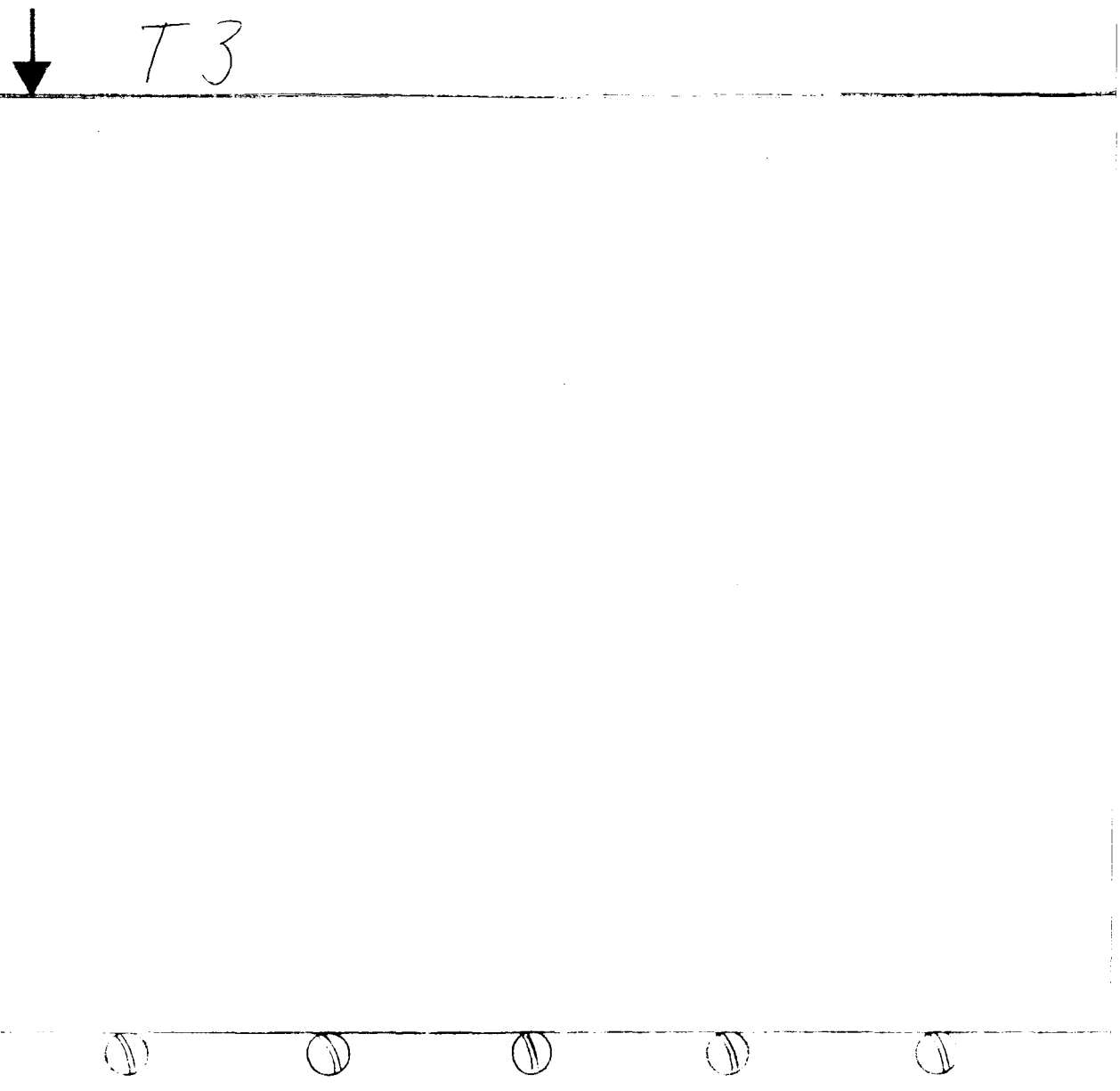
J3
DC INPUT
A+ FLOATING
B-
C CHASSIS GND
BENDIX(PT07H

CONNECTOR PIN ASSIGNMENTS

T 2



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T 4

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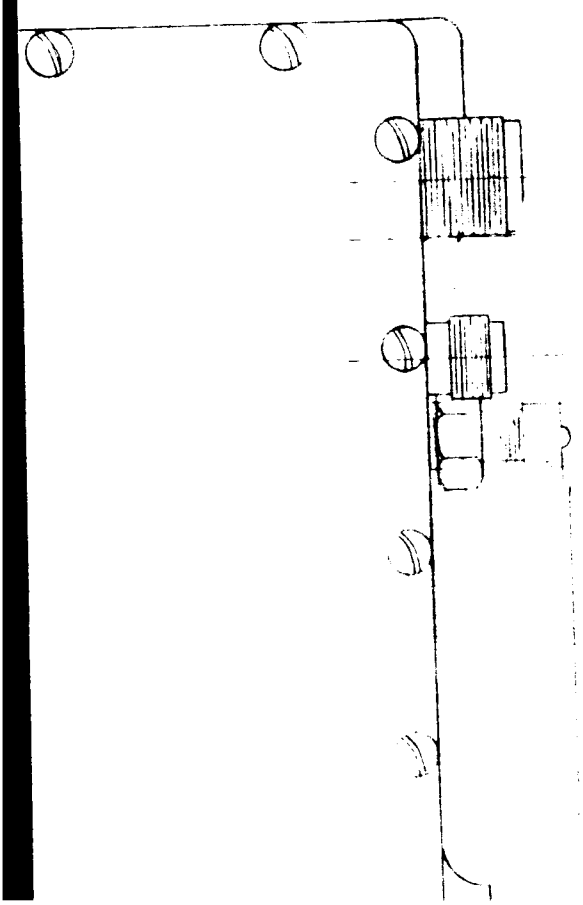

JB
EXCITER OUTPUT
AUTOMATIC
METALS INC
(101-T3101-75)
TYPE TNC

T5

SIONS

	DATE	APPROVED
[illegible]	[illegible]	[illegible]

J6
TWT INPUT
AUTOMATIC
METALS INC
(101-1381-01-75)
TYPE TNC

J7
RF OUTPUT
AUTOMATIC
METALS INC
(101-1138-01-85)
TYPE N

MP2
PRESSURE

Bottom 1

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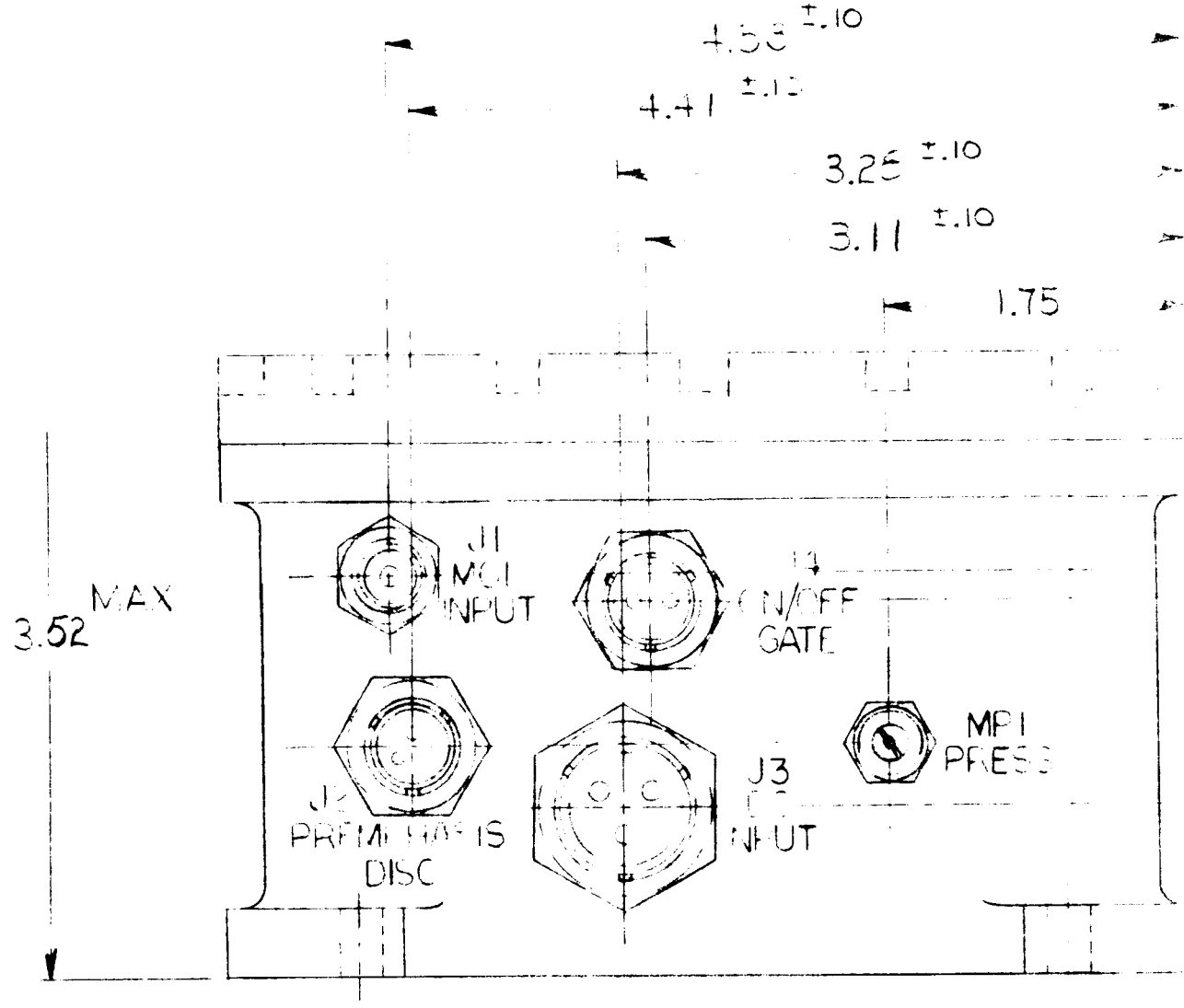
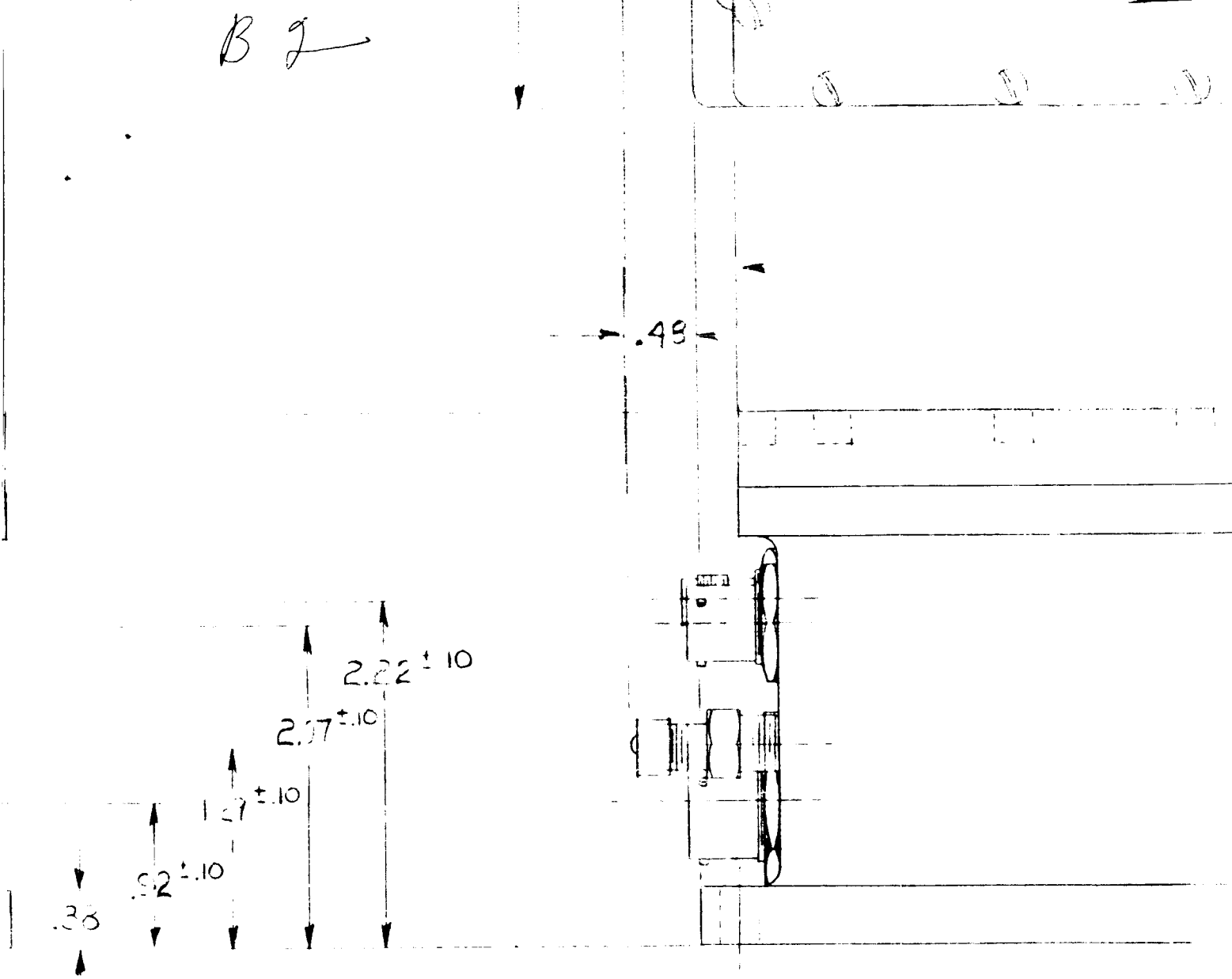


NOTES: UNLESS OTHERWISE

B 2



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MATERIAL

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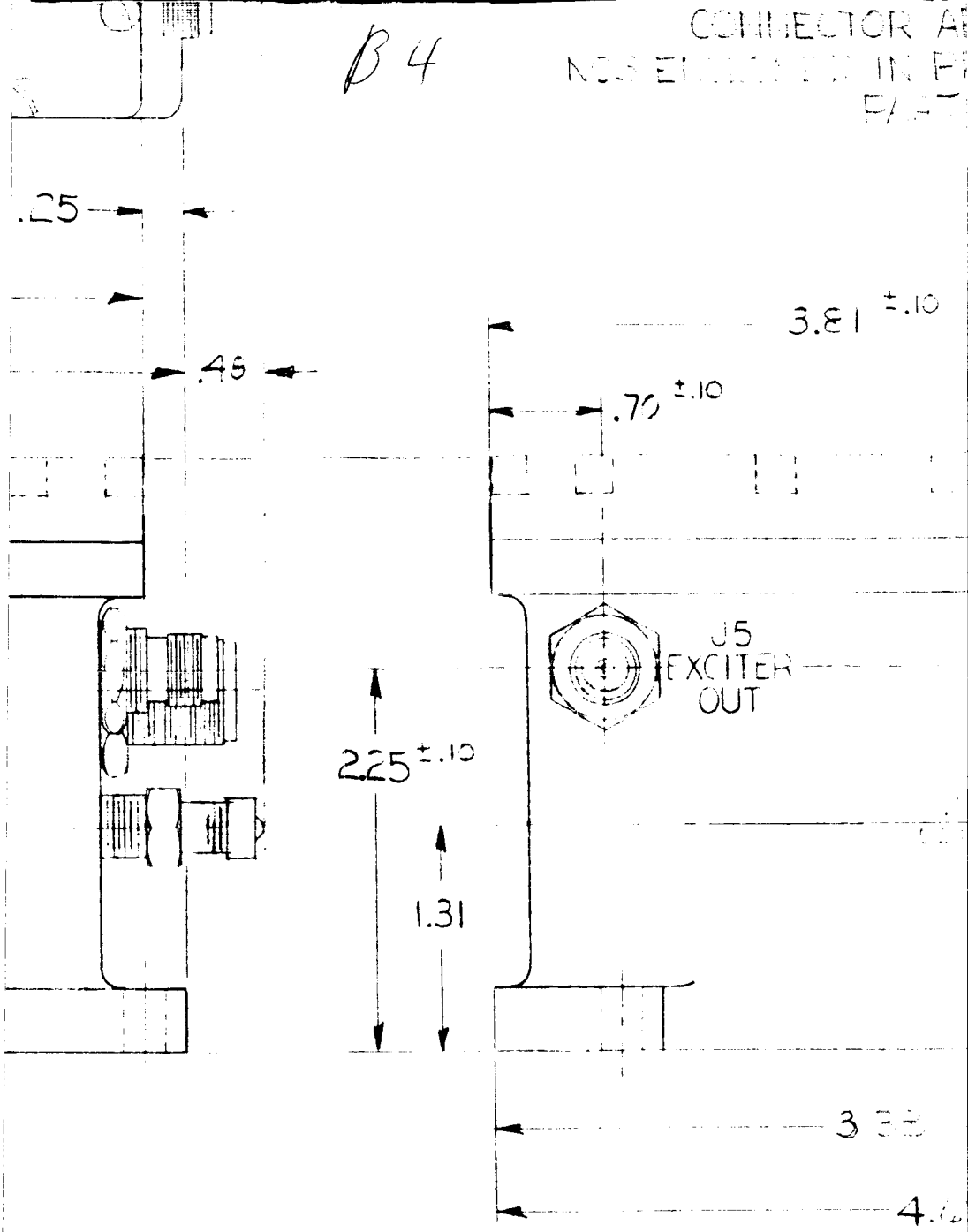

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SCALE 1/1 | REL

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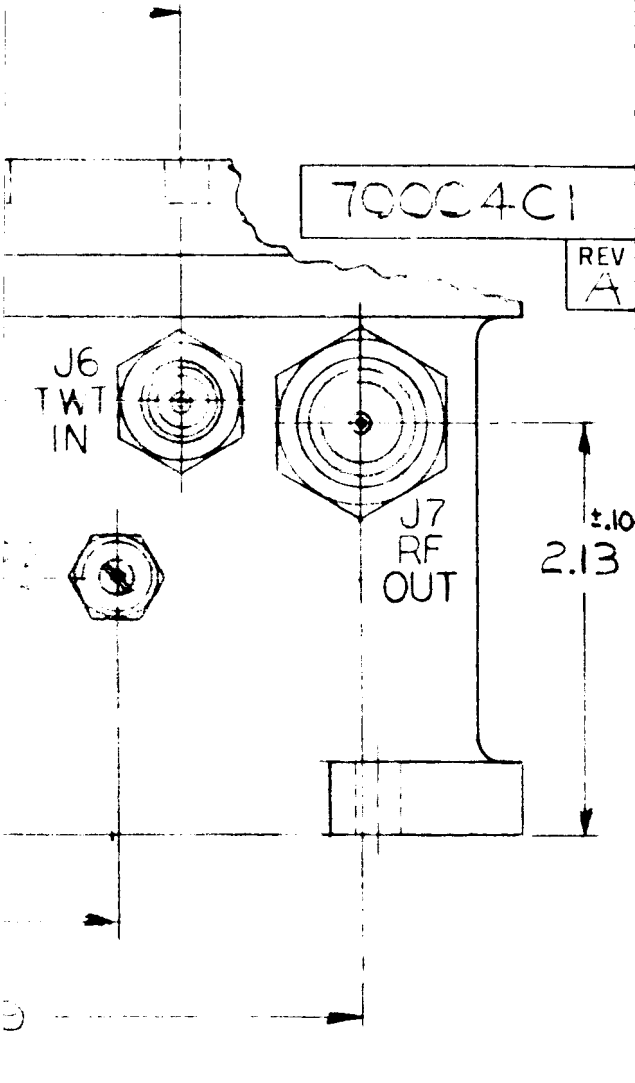
NCS

B5



ERGY SYSTEMS, INC.

SPECIFICATIONS-
ER, TELEVISION, S BAND
SYSTEM

7000C4C1

DATE 6/2 SHEET 1 OF 1